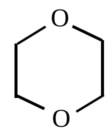
1,4-DIOXANE

1,4-Dioxane is a federal hazardous air pollutant and was identified as a toxic air contaminant in April 1993 under AB 2728.

CAS Registry Number: 123-91-1



Molecular Formula: $C_4H_8O_2$

1,4-Dioxane is a highly flammable, colorless liquid. It is miscible with water, most organic solvents, aromatic hydrocarbons, and oils. 1,4-Dioxane may form explosive peroxides especially when anhydrous (Merck, 1989). It is also not suitable for being mixed or used with strong oxidizers (Sittig, 1985). Carbon monoxide, toxic gases and vapors may be released if 1,4-dioxane is combusted (HSDB, 1991).

Physical Properties of 1,4-Dioxane

Synonyms: 1,4-diethylene dioxide; diethylene ether; p-dioxane; dioxane

Molecular Weight:	88.10
Boiling Point:	101.1 ^{o}C
Melting Point:	11.8 ^{o}C
Flash Point:	5 - 18 ^{o}C (closed cup)
Vapor Density:	3.03 (air = 1)
Density/Specific Gravity:	1.0329 at 20/4 ^{o}C (water = 1)
Vapor Pressure:	38.0 mm Hg at 25 ^{o}C
Log Octanol/Water Partition Coefficient:	-0.27
Conversion Factor:	1 ppm = 3.6 mg/m^3

(Howard, 1990; U.S. EPA, 1994a)

SOURCES AND EMISSIONS

A. Sources

1,4-Dioxane is primarily used as a solvent in products such as paints, varnishes, lacquers, paint and varnish removers, cosmetics, and deodorants. It is also used as a solvent in the pulping of wood, fats, oils, waxes, and natural and synthetic resins, and as a degreasing agent and a fluid for scintillation counter samples. 1,4-Dioxane can be used as a stabilizer for chlorinated solvents such as 1,1,1-trichloroethane. Millions of pounds of 1,4-dioxane are produced in the United States each year. Approximately 90 percent of it is used for stabilizing chlorinated solvents and about 10 percent in solvent applications (HSDB, 1991).

The primary stationary sources that have reported emissions of 1,4-dioxane in California are coating, engraving, and allied metal services manufacturing, manufacturers of aircraft and parts, and sanitary services (ARB, 1997b).

B. Emissions

The total emissions of 1,4-dioxane from stationary sources in California are estimated to be at least 210,000 pounds per year, based on data reported under the Air Toxics “Hot Spots” Program (AB 2588) (ARB, 1997b).

C. Natural Occurrence

No information about the natural occurrence of 1,4-dioxane was found in the readily-available literature.

AMBIENT CONCENTRATIONS

No Air Resources Board data exist for ambient measurements of 1,4-dioxane. However, the United States Environmental Protection Agency (U.S. EPA) has compiled ambient air data from several urban and suburban locations throughout the United States. The mean ambient concentration was 0.44 micrograms per cubic meter ($\mu g/m^3$) or 0.12 parts per billion from 1979-84 (U.S. EPA, 1993a).

INDOOR SOURCES AND CONCENTRATIONS

Sources of 1,4-dioxane include usage as a degreasing agent and as a solvent. Possible indoor sources include architectural coatings, adhesives, and cleaning and detergent preparations (Hodgson and Wooley, 1991).

The California Total Exposure Assessment Methodology (TEAM) studies were conducted in and around Los Angeles during two seasons in 1984 and 1987 and in Contra Costa County in 1984. For the three field studies conducted during 1984, 1,4-dioxane was detected in 12 to 55 percent of the samples analyzed. The indoor average concentrations ranged from 0.15 to 0.53 $\mu g/m^3$. During the follow-up study in 1987, 1,4-dioxane was detected in less than 17 percent of the samples analyzed, and all samples were below the quantifiable limit of 0.60 $\mu g/m^3$ (Pellizzari et al., 1987b; 1989).

In June of 1990, 125 households in Woodland, California, were monitored for a variety of toxic air contaminants. Approximately 21 percent of the indoor samples collected contained measurable amounts of 1,4-dioxane. The average concentration of 1,4-dioxane was below the quantifiable limit of 0.11 $\mu g/m^3$, and the measurements ranged from below the quantifiable limit to 140 $\mu g/m^3$ (Sheldon et al, 1992).

ATMOSPHERIC PERSISTENCE

1,4-Dioxane will exist in the atmosphere in the gas phase. The dominant tropospheric chemical loss process for 1,4-dioxane is by reaction with the hydroxyl (OH) radical. Because of its reaction with the OH radical, 1,4-dioxane has a calculated half-life and lifetime of 0.9 days and 1.3 days, respectively (Atkinson, 1995).

AB 2588 RISK ASSESSMENT INFORMATION

The Office of Environmental Health Hazard Assessment reviews risk assessments submitted under the Air Toxics "Hot Spots" Program (AB 2588). Of the risk assessments reviewed as of April 1996, 1,4-dioxane was the major contributor to the overall cancer risk in 8 of the approximately 550 risk assessments reporting a total cancer risk equal to or greater than 1 in 1 million and contributed to the total cancer risk in 61 of the these risk assessments. 1,4-Dioxane also contributed to the total cancer risk in 23 of the approximately 130 risk assessments reporting a total cancer risk equal to or greater than 10 in 1 million (OEHHA, 1996a).

For the non-cancer health effects, 1,4-dioxane contributed to the total hazard index in 9 of the approximately 89 risk assessments reporting a total chronic hazard index greater than 1. 1,4-Dioxane also contributed to the total hazard index in 9 of the approximately 107 risk assessments reporting a total acute hazard index greater than 1, and presented an individual hazard index greater than 1 in 1 of these risk assessments (OEHHA, 1996b).

HEALTH EFFECTS

Probable routes of human exposure to 1,4-dioxane are inhalation and dermal contact (HSDB, 1991).

Non-Cancer: Short-term inhalation exposure may cause irritation of the eyes, nose, throat, and lungs. Symptoms of acute exposure include coughing, drowsiness, vertigo, headache, nausea, vomiting, stomach pains, coma, and death. There is a report of a fatal case of acute poisoning by inhalation that led to hepatic and renal lesions, and demyelination and edema of the brain (U.S. EPA, 1994a).

An acute non-cancer Reference Exposure Level (REL) of 2000 $\mu g/m^3$ and a chronic REL of 400 $\mu g/m^3$ are listed for 1,4-dioxane in the California Air Pollution Control Officers Association

Air Toxics "Hot Spots" Program, Revised 1992 Risk Assessment Guidelines. The toxicological targets considered for chronic toxicity are the central or peripheral nervous system, gastrointestinal system, respiratory system, liver and kidney. The acute toxic endpoint is eye irritation (CAPCOA, 1993). The U.S. EPA has not established a Reference Concentration (RfC) or an oral Reference Dose (RfD) for 1,4-dioxane (U.S. EPA, 1994a).

No information is available on adverse reproductive or developmental effects caused by 1,4-dioxane in humans. In studies where animals were exposed to 1,4-dioxane via gavage, no evidence of gross, skeletal, or visceral malformations were found in the offspring. Embryotoxicity was observed only at the highest dose (U.S. EPA, 1994a).

Cancer: In three epidemiologic studies on workers exposed to 1,4-dioxane, the observed number of cancer cases did not differ from the expected cancer deaths. Increased incidences of liver carcinomas and adenomas, and nasal cavity squamous cell carcinomas were reported in several studies of rats and mice exposed to 1,4-dioxane in their drinking water (U.S. EPA, 1994a).

The U.S. EPA has classified 1,4-dioxane in Group B2: Probable human carcinogen. The U.S. EPA has calculated an oral unit risk estimate of 3.1×10^{-7} (microgram per liter)$^{-1}$ (U.S. EPA, 1994a). The U.S. EPA estimates that if an individual were to drink water containing 1,4-dioxane at 3.0 micrograms per liter, over an entire lifetime, that person would theoretically have no more than a 1 in 1 million increased chance of developing cancer. The International Agency for Research on Cancer has classified 1,4-dioxane in Group 2B: Possible human carcinogen (IARC, 1987a).

The State of California has determined under Proposition 65 that 1,4-dioxane is a carcinogen (CCR, 1996). The inhalation potency factor that has been used as a basis for regulatory action in California is 7.7×10^{-6} (microgram per cubic meter)$^{-1}$ (OEHHA, 1994). In other words, the potential excess cancer risk for a person exposed over a lifetime to 1 $\mu g/m^3$ of 1,4-dioxane is estimated to be no greater than 7.7 in 1 million. The oral potency factor that has been used as a basis for regulatory action in California is 2.7×10^{-2} (milligram per kilogram per day)$^{-1}$ (OEHHA, 1994).